Mitsuhiro NAKASHIMA*: Spore germination and protonema development in *Hygrobiella nishimurae* N. Kitag., Hepaticae

中島光博*: ニシムラエゾヒメヤバネゴケにおける胞子発芽と原糸体の発達

The genus *Hygrobiella* in the family Cephaloziaceae seems to consist of two species: *H. laxifolia* (Hook.) Spr. and *H. nishimurae* N. Kitag. (Kitagawa 1982). *H. nishimurae* was described as a new species on the basis of several specimens collected from a few sites in Japan by Kitagawa (1982). Nakashima (1984) studied the sporophyte of *H. nishimurae* and stated that there are no remarkable differences between the sporophyte of *H. laxifolia* and that of *H. nishimurae*.

On the other hand, spore germination and protonema development in the genus *Hygrobiella* have never been studied. In this paper, spore germination and protonema development of *H. nishimurae* will be discussed and also compared to those of 4 other Cephaloziaceae genera: *Cephalozia, Nowellia, Odontoschisma,* and *Schiffneria,* which have already been investigated by several researchers.

Material and method Plants with mature sporangia of *H. nishimurae* were collected from wet boulders along a stream in a deciduous broad-leaved forest in Hiramidani (620 m in altitude), Hiroshima-ken on February 28, 1982. The spores were sown on March 3, 1982.

A medium comprised of one-half-strength Knop's solution was used for culture study. Spores from mature capsules, well washed with distilled water, were sown in closed petri dishes with about 20 ml of autoclaved medium. The cultures were maintained between 20–23°C under light for 12 hours a day. The light source used was fluorescent with an intensity of about 2,500 lux. Observations were carried out for a month.

Observations Spores with several chloroplasts were finely papillose and spherical, measuring about 18–22 μm in diameter (Fig. 1 a). Within a few days,

* Hiroshima Municipal Asakita Senior High School, Asakita-ku, Hiroshima-shi, Hiroshima 731-02. 広島市立安佐北高等学校.

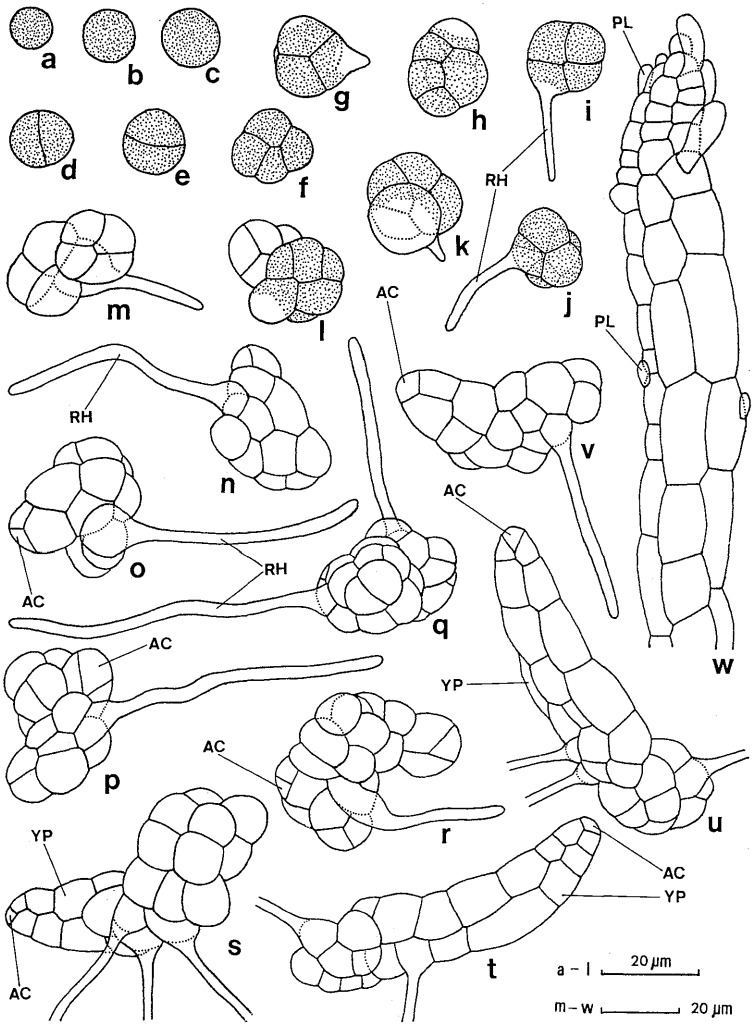

Fig. 1. Spore germination and protonema development in *Hygrobiella nishimurae* N. Kitag. a. Spore. b, c. Swollen spores. d, e. 2-celled protonemata. f-r. Massive and irregular protonemata with rhizoids. s-v. Young plant formed from a massive and irregular protonema with rhizoids. w. Leafy shoot with primary leaves on a young plant. RH. Rhizoid. AC. Apical cell. YP. Young plant. PL. Primary leaf.

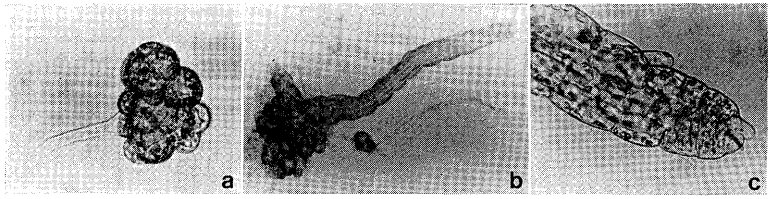

Fig. 2. Protonema development in *Hygrobiella nishimurae* N. Kitag. a. Massive and irregular protonema with a rhizoid (×250). b. Massive and irregular protonema forming young plant (×50). c. Upper part of a leafy shoot with primary leaves (×250).

the spores swelled to about 22-26 μm in diameter (Fig. 1 b, c), and the first cross wall was formed making two cells of the same size. These 2-celled protonemata developed into massive ones with rhizoids. Large parts of these 2-6-celled massive protonemata were covered with thin spore walls which were obscurely recognizable (Fig. 1 d-k). After the spore walls ruptured, several-celled protonemata developed into massive and irregular protonemata (Fig. 1 l-n; Fig. 2 a). Furthermore, a few apical cells with three cutting faces began to develop into massive cells in about 10 days (Fig. 1 o-r). After a few young plants developed directly through cell segmentation (Fig. 1 s-v; Fig. 2 b), leafy shoots with primary one-celled leaves were formed on the upper parts of the young plants without leaves in a month (Fig. 1 w; Fig. 2 c). Generally, a few plants developed from one spore.

Discussion The types of the spore germination in Jungermanniales are divided into the following two basic types: the exosporous type in which protonemata are formed outside the spore wall, and the endosporous type in which protonemata are formed inside the spore wall (Fulford 1956, Schuster 1966, Nehira 1966, 1983). In the early stages of spore germination in *H. nishimurae*, protonemata developed inside their spore walls. Later, subsequent to exospore rupture, massive secondary protonemata developed. Such a germination type with dimorphic protonemata is divided into two groups: *Ceratolejeunea*-type and *Pleurozia*-type (Nehira 1983). The spore walls covering the primary protonemata of species in both *Ceratolejeunea* and *Pleurozia* are thick. However, those in *Hygrobiella* are very thin. So, the spore walls of *Hygrobiella nishimurae* are different from the spore walls of species in the genera *Ceratolejeunea* and *Pleurozia*. On the other hand, according to Fulford (1956),

primary leaves organized in one row are characteristic of exosporous germination species, while primary leaves organized in several rows are characteristic of endosporous germination species. Since the primary leaves of *H. nishimurae* are one-celled and are organized in one row, we can conclude that its spore germination is exosporous.

Excluding the protonemata formed inside spore walls in the early stage, germination in *Hygrobiella nishimurae* is similar to the *Nardia*-type in which it forms irregular and massive protonemata.

The types of the spore germination in Cephaloziaceae were studied in genera of *Cephalozia*, *Nowellia*, *Odontoschisma* and *Schiffneria* (Goebel 1889, Fulford 1955, Nehira 1962) and included into the exosporous germination group as summarized by Nehira (1983). Germination in the species of *Cephalozia*, *Nowellia* and *Schiffneria* belongs to the *Cephalozia*-type of the spore germination which has filamentous protonemata (Nehira 1983). But the species of the genus *Odontoschisma* belong to the *Nardia*-type spore germination group and are characterized by various forms of protonemata (Nehira 1983). The types of the spore germination in *Odontoschisma denudatum* (Nees) Dum. and *O. grosseverrucosum* Steph., as observed by Nehira (1962), are of the *Nardia*-type, but the protonemata of these species are filamentous. So the type of the spore germination in the genus *Odontoschisma* is very similar to *Cephalozia*-type spore germination. On the other hand, *Hygrobiella* protonemata are not filamentous, but are massive and irregular. As mentioned above, the type of the spore germination in *Hygrobiella* distinctly differs from the types in the 4 genera of Cephaloziaceae in the formation of either filamentous or massive and irregular protonemata.

The author wishes to express many thanks to Prof. K. Nehira of Hiroshima University for his valuable suggestions and his critical reading of this manuscript and is also grateful to Caroline F. Benton of Hiroshima Prefectural Board of Education and C. Takamura of Hiroshima Prefectural Koyo-higashi Senior High School for kindly reading this manuscript and offering valuable criticisms.

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苔類のヤバネゴケ科に属するエゾヒメヤバネゴケ属の胞子発芽と原糸体の発達を，ニシムラエゾヒメヤバネゴケを用いて調べた。その結果，本種の胞子発芽は基本的には胞子外膜外発芽であり，原糸体は不規則な塊状形になり糸状にはならない。したがって，本種の胞子発芽は *Nardia* 型である。一方これまで調べられているヤバネゴケ科の種の胞子発芽は，胞子外膜外発芽で *Cephalozia* 型（ヤバネゴケ属，フクロヤバネゴケ属，シフネルゴケ属）と *Nardia* 型（クチキゴケ属）の二型が知られているが，いずれの場合も糸状の原糸体を形成する。この点で，エゾヒメヤバネゴケ属の原糸体の形状は他のヤバネゴケ科に属する種の原糸体とは幾分異なることがわかった。

○高等植物分布資料 (121) Materials for the distribution of vascular plants in Japan (121)

○テマリツメクサ *Trifolium aureum* Poll. 原子は1986年8月1日，青森県大鰐町でクスダマツメクサに似た大型の *Trifolium* を採集し，金井がこれを調べたところヨーロッパ原産の *Trifolium aureum* で，本誌60巻256頁に秋山忍氏により那須から記録されたテマリツメクサであった。最近完成した舗装道路沿いに点々と生育している。お教えいただいた浅井康宏氏に謝意を表する。

(国立科学博物館 金井弘夫 Hiroo KANAI・青森第三養護学校 原子一男 Kazuo HARAKO)